fore the electron density in the plasma and the associated intensity of light emission by the atoms should depend on the degree of spin orientation of the metastable atoms. Apparently, a competing process of opposite sign is also present here, and leads with increasing discharge intensity to a reversal of the sign of the resonant change of the radiation intensity[6]. It is possible that this process is the optical transition $2^3S_1 \rightarrow 2^3P_1$ with subsequent decay $2^3P_1 - 1^1S_0$, leading to a drop of the concentration of the metastable atoms; this drop increases with increasing discharge intensity.

The described phenomena could be observed also following optical pumping of helium-3 atoms in the metastable state. Experiments on helium-3 atoms are presently being performed to verify the proposed explanations of the nature of these phenomena.

Optical orientation of metastable neon and xenon atoms was obtained both with circularly polarized and unpolarized light. These investigations of optical pumping of inert-gas atoms in the P state, which are of considerable theoretical interest, are presently being continued.

Work on the development of new quantum-electronic devices based on optical orientation of atoms is presently being performed at the Physico-technical Institute of the USSR Academy of Sciences.

A new type of quantum magnetometer, namely a self-generating quantum magnetometer with optical orientation of metastable atoms of helium-4 (GSM-4)[7], has been developed. This magnetometer has many advantages over the existing instruments. Thus, unlike the magnetometer based on alkali-metal atoms, the helium magnetometer has a simple resonance line, a linear connection between the magnetic field and the resonant frequency, and a weak independence of the temperature. Compared with the existing helium magnetometers, based on the scheme of automatic tuning of the generator frequency, the self-generating magnetometer GSM-4 has the advantages of simplicity, compactness, and reliability, which are ensured by a spin generator[7].

A model was also developed of a self-generating magnetometer based on optical orientation of the nuclear moments of helium-3 (GSM-3). This magnetometer has many advantages when it comes to perform measurements under static conditions.

A special procedure was developed for constructing absorbing cells capable of producing simultaneous optical orientations of helium atoms and alkali-metal atoms in a single cell[8]. Methods were also developed for stabilizing magnetic fields with the aid of spin generators with optical pumping of alkali-metal and helium atoms. These results can be used for the development of new types of nuclear quantum-gyroscopes with optical pumping.

The main results of the paper were published in[3-8].

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V. B. Anzin, M. S. Bresler, V. G. Veselago, Yu. V. Kosichkin, G. E. Pikus, I. I. Farbshteĭn, and S. S. Shalyt. Experimental Observation of Magnetic Breakdown in Semiconductors.

Besides interband magnetic breakdown, which is observed in a large number of metals, there have been also theoretical studies of intraband magnetic breakdown, when the carriers execute internal transition between trajectories pertaining to different valleys of the same energy band, something possible if the energy spectrum has a saddle point.

In the present paper it is established, as a result of the investigation of the Shubnikov-de Haas (SH) effect in tellurium single crystals, that the energy spectrum of the valence band of tellurium has a saddle point located 2 meV away from the edge of the band, and intraband magnetic breakdown of the carrier trajectories was observed for Fermi energies close to the saddle-point energy. It was shown that the hole dispersion law is described by the expression

$$\varepsilon = Ak_z^2 + Bk_\perp^2 - \sqrt{\Delta^2 + c^2k_z^2}, \qquad (1)$$

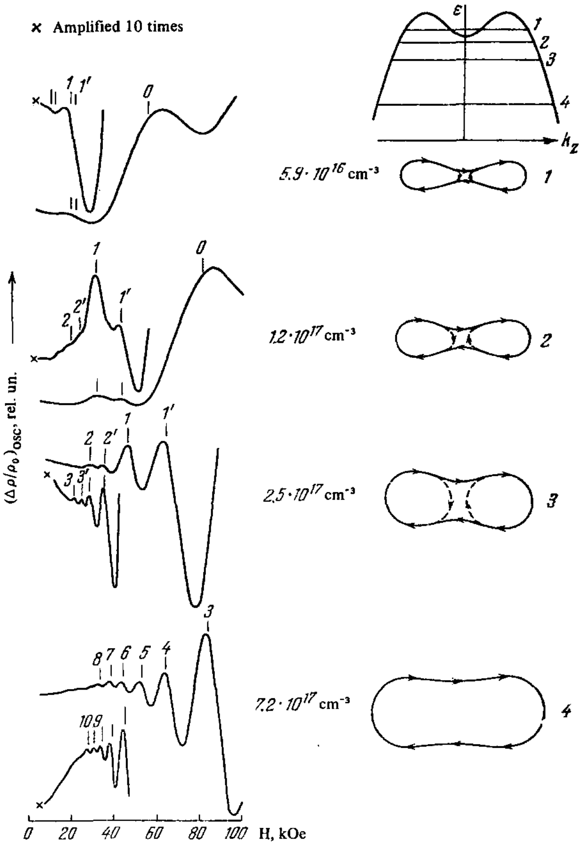
and the numerical values of the parameters were determined from the experimental data[1,2].

According to (1), at a hole concentration $p_{cr} = 6 \times 10^{16}$ cm^{-3} (corresponding to the saddle-point energy) in a magnetic field $H \perp C_3$ (C_3 is the trigonal axis of the crystal), the carriers describe trajectories with self-intersection.

Zil'berman and Azbel'[3,4] have shown that such a motion cannot be considered in the quasiclassical approximation; a quantum-mechanical analysis indicates in this case the possibility of simultaneous realization of two trajectories—a complete dumbell-like and almost elliptical one, encompassing approximately half as large an area, this being the consequence of the carrier tunneling from one quasiclassical orbit to another (intraband magnetic breakdown).

For the model under consideration, magnetic breakdown at $p > p_{cr}$—breakdown of the neck of the dumbell—leads to the appearance of additional intersections at $H \perp C$[1,2]. At $p < p_{cr}$, the carrier jumps over from one elliptical orbit to another and forms a trajectory that encircles approximately double the area.

In the exact solution, such a qualitative picture corresponds to splitting, in the magnetic field, of the system of levels for one ellipsoid into two subsystems, corresponding to two types of carrier orbits in the magnetic field. As a result it becomes possible to ob-



serve a magnetoresistance maximum corresponding to the zero Landau level.

The figure shows the experimental results of the investigation of the SH oscillations in a magnetic field up to 100 kOe at liquid-helium temperature, on samples with different hole concentrations near p_{cr}.

The results indicate that realization of magnetic breakdown leads to simultaneous appearance in the oscillations of harmonics corresponding to two types of possible carrier trajectories, and the contribution of each of the trajectories to the quantum SH oscillations changes with increasing concentration, i.e., with changing breakdown probability.

The quantization formulas given in Azbel's paper[4], and also the quasiclassical quantization rules, which can be used at energies sufficiently far from the critical value, make it possible to plot the position of the Landau levels against the magnetic field for the dispersion law (1). Such a calculation is in satisfactory agreement with the presented experimental data.

The investigated angular dependence of the position of the zero maximum of the oscillations on the angle between the direction of the magnetic field H and the axis C_3 confirms the interpretation wherein the observed phenomenon is regarded as intraband magnetic breakdown.

The results presented in the paper were published in[1,2,5].

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M. S. Rabinovich. Stellarator Program

The stellarator program was and remains one of the main programs of controlled thermonuclear fusion (CTF). The principle of plasma containment is the same in the stellarator as in the Tokamak. Plasma containment is determined by the magnetic surfaces with sufficiently large angle of rotation of the force lines (i), shear $\theta = (r^2/R)di/dr$, where r and R are the minor and major radii of the torus, and the well of the magnetic field averaged along the force line $\langle H\rangle = \{\lim_{l\to\infty}(1/l)\int dl/H\}$. The shortcomings of the stellarator are the absence of axial symmetry, the diffuculties in producing the magnetic field and, consequently, and the lower efficiency of magnetic-field energy utilization. Its advantage lies in the possibility of controlling the field parameters, attaining large angles i, and producing stationary installations, and in the great variety of configurations. The first stage in the stellarator program is the production of the necessary magnetic fields and of methods of measuring and correcting the magnetic surfaces. This necessary stage of research has already been performed. An attempt to bypass this stage has caused failure of the stellarator program of the Princeton Plasma Physics Laboratory, where the stellarator idea itself was originated in 1952 (L. Spitzer). At the present time, ideal magnetic surfaces with angle $i = 6\pi$ (Physics Institute, USSR Academy of Sciences), large shear $\theta = 0.1$ (Physico-technical Institute, Ukrainian Academy of Sciences and Culham, England).

The second stage of the stellarator program is an investigation of plasma containment. The main results of this stage are as follows:

1) In the kinetic regime (mean free path larger than the perimeter of the apparatus), at temperatures $T_e = 5-10$ eV and $T_i = 20-40$ eV, and a plasma density $n < 10^{11}$ cm^{-3}, the particle lifetime is proportional to the angle of rotation of the force lines, and at a shear of $\theta \gtrsim 0.05$ it differs by a factor of 5 from the "classical" values determined by pair collisions.

2) At certin resonant values of the angle i, when the force line is closed after a small number of turns, $i/2\pi = p/q$, where p and q are small integers, a sharp decrease of the plasma lifetime is observed, apparently resulting from the formation of convective cells.

3) In the hydrodynamic regime, classical lifetimes were obtained in a cold plasma (Garsching, West Germany). In this case, however, the Bohm time is smaller than the classical only by one order of magnitude. The "Uragan" apparatus (Physico-technical Institute of the Ukrainian Academy of Sciences) pro-